Ordovician–Silurian boundary, northern Yukon, Canada

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Synopsis

The Ordovician–Silurian boundary is described from three graptolite and conodont-bearing sections of northern Yukon. Upper Ordovician graptolite biostratigraphical units comprise the *Dicellograptus ornatus*, *Pacificograptus pacificus* and tentatively the *Glyptograptus persculptus* zones; that of the conodonts being the *Amorphognathus ordovicicus* Biozone and the North American Fauna 12. A stratigraphical hiatus between the *P. pacificus* Zone and the *G. persculptus* Zone?, and probably equivalent to the *Diplograptus bohemicus* and *Climacograptus*? *extraordinarius* graptolite Zones, and to North American conodont Fauna 13, appears to be present everywhere in the region.

Introduction

The presence of excellently exposed graptolite-bearing sequences in the Richardson and Ogilvie mountains of northern Yukon has been recognized for more than 20 years. Graptolitic strata of the Road River Formation are known to be widely distributed throughout the northern Cordillera of Canada and adjacent Alaska (e.g. Lenz & Perry 1972; Lenz 1972, 1982; Churkin & Brabb 1965).

For the purpose of this paper, three key sections are discussed; these are Peel River, Pat Lake and Blackstone River, the first in the Richardson Mountains, the latter two in the Ogilvie Mountains (Figs 1, 2). The Peel River section is chosen because the Ordovician–Silurian boundary beds are completely exposed and are well studied, and are defined on both graptolites and conodonts; Pat Lake contains a thick conodont and shelly fauna-bearing limestone of probable latest Ordovician age in an otherwise entirely graptolitic sequence; and Blackstone River is a much thicker boundary sequence containing both graptolites and conodonts. These sequences have already been discussed in Lenz & McCracken (1982).

The three sections discussed are in remote and isolated areas of northern Yukon, the field season is relatively short, seldom more than two and a half months, and the cost of access is high. Access to any of the three localites is via regular scheduled aircraft service to Whitehorse in southern Yukon, and then to the villages of either Mayo or Dawson City in central Yukon (Fig. 1), and by privately chartered helicopter thereafter. Weather in the region can vary considerably, but is generally pleasant in July and early August.

Stratigraphy

The Road River Formation, the type of which is in the Richardson Mountains (Jackson & Lenz 1962), is a thick basinal sequence of dominantly dark grey to black shales and cherts with minor dark limestone beds and a few relatively thick-bedded debris-flow carbonates. Graptolites are common to abundant in the shales and conodonts occur in some of the thin, dark limestone beds. The Peel River section is a more or less typical Richardson Mountains boundary sequence, but is without significant carbonates.

The Road River strata of the Ogilvie Mountains, of which the Pat Lake and Blackstone River sections are representative, are characterized mainly by thinly bedded dark shales and calcareous shales, much greater amounts of dark limestone beds and laminae, and much less chert. The shales and calcareous shales contain abundant graptolites, while the dark limestones

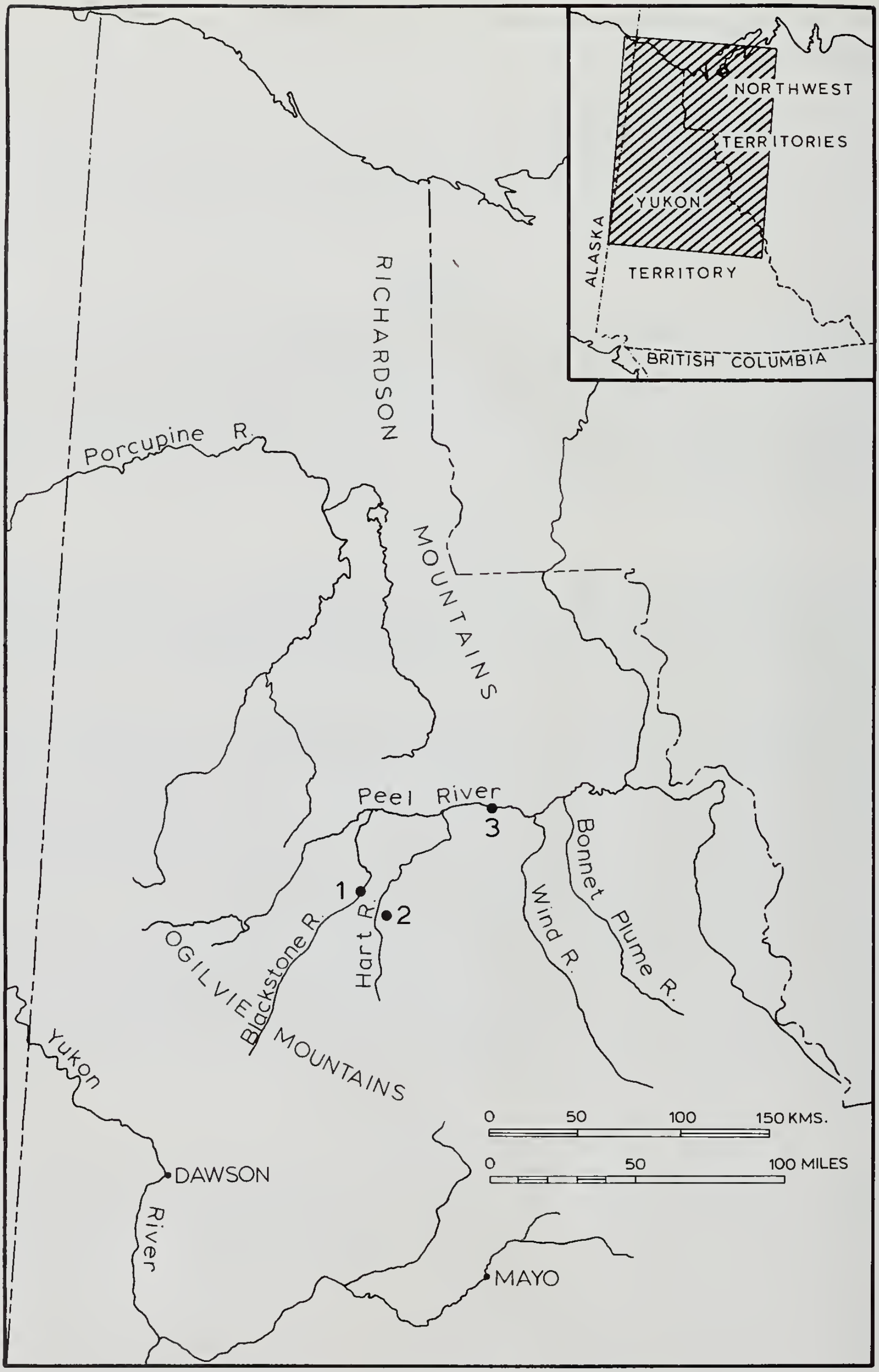

Fig. 1 Index map of northern Yukon showing localities. 1 = Blackstone River; 2 = Pat Lake; 3 = Peel River.

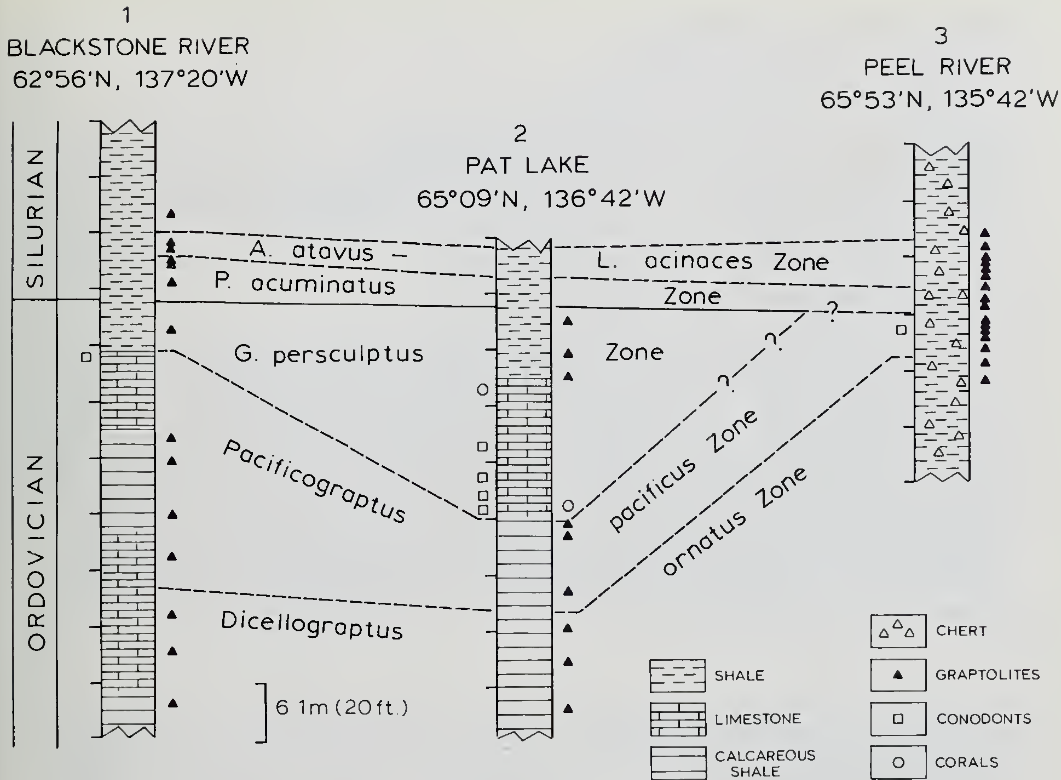

Fig. 2 Correlation of graptolite zones of localites 1–3 (Fig. 1), using the base of the Silurian as a datum.

may contain conodonts and, rarely, trilobites (e.g. Lenz & Churkin 1966; Ludvigsen 1981). A relatively thick sequence of light-coloured, probably shallow water, conodont and coral-bearing limestone of probable latest Ordovician age (*Glyptograptus persculptus* Zone?) occurs in the Pat Lake section (Fig. 1). The presence of the limestone is anomalous, and its origin may be related to the widely recognized latest Ordovician glacially induced regression (e.g. Lenz 1976, 1982; Lenz & McCracken 1982).

Graptolites

Ashgill graptolite faunas of the northern Cordillera are divisible into two biostratigraphical units, a lower *Dicellograptus ornatus* Zone and the upper *Paraorthograptus pacificus* Zone. The uppermost Ordovician, the *G. persculptus* Zone, is less well developed and is clearly absent from the Peel River section, but is tentatively recognized in the Pat Lake and Blackstone River sections. Lowest Silurian (Llandovery) strata, represented by the *Parakidograptus acuminatus* Zone and the overlying *Atavograptus atavus* and *Lagarograptus acinaces* Zones are widely recognized (Lenz 1982).

The *D. ornatus* Zone is characterized by the index species, and by *D. minor*, *Glyptograptus latus*, *Climacograptus longispinus*, *C. latus*, *C. hvalross*, *C. hastatus*, *C. supernus*, *Orthograptus abbreviatus*, *O.* cf. *fastigatus*, *Orthoretiograptus denticulatus*, *Arachniograptus laqueus* and *Leptograptus* spp. *Dicellograptus* is common, as are most of the diplograptid species.

The *P. pacificus* Zone is taxonomically a much more impoverished fauna and is characterized by an abundance of *C. supernus* and *P. pacificus*. Most of the species of diplograptids noted in the *D. ornatus* Zone are present, but in much lesser numbers, and dicellograptids are rare. In addition, the exotic *Diceratograptus* cf. *mirus* is represented by two specimens in the Peel River section (Chen & Lenz 1984).

The supposed *G. persculptus* Zone, which was considered to be lowest Silurian in Lenz & McCracken (1982), is characterized by a fauna of low diversity, and is only tentatively recognized. The index species has not, to date, been recovered from the northern Canadian Cordillera, although it does occur in southeastern Alaska (Churkin *et al.* 1971). This biostratigraphical unit is distinguished by the relatively sudden appearance of narrow forms of *Climacograptus normalis* and *C. miserablilis*, a very spinose form of ?*Paraorthograptus* and *Orthograptus* cf. *abbreviatus*. Other species appearing in the interval, but not confined to it, include *Diplograptus modestus*, *Glyptograptus tamariscus*, *G. gnomus*, *G.* cf. *laciniosus*, and *G.* cf. *lanpheri*. Monograptids have not been recovered. The *G. persculptus* Zone? is absent in the Peel River section.

The *P. acuminatus* Zone, the lowest Silurian biostratigraphical unit, is readily recognized by the appearance of the index species, as well as *Climacograptus* cf. *trifilis*, ?*Akidograptus ascensus*, *Cystograptus vesiculosus* and *Diplograptus modestus diminutus*. Monograptids have not been found. The *A. atavus* and *L. acinaces* Zones are discussed together since they witness the incoming of monograptids, particularly *Atavograptus* and *Pribylograptus*, as well as being characterized by *Dimorphograptus confertus swanstoni*, *D. physophora* (and subspecies) and common *Cystograptus vesiculosus*.

Graptolite correlation

The graptolitic sequences of the northern Cordillera are directly comparable to those in central China and the Kolyma and Kazakhstan regions of the U.S.S.R., and indirectly with that of southern Scotland (Lenz & McCracken 1982; Chen & Lenz 1984). The *D. ornatus* Zone is directly comparable to the *C. longispinus* Subzone of Koren *et al.* (1979), more or less comparable with the *D. szechuanensis* Zone and possibly the *Amplexograptus yangtzeensis* Zone of central China (Chen & Lenz 1984), and probably with the *D. complanatus* Zone of Scotland (Williams 1982).

Correlation of the *P. pacificus* Zone of Yukon is almost certainly directly with the *P. pacificus* Subzone of U.S.S.R., but comparison with the Chinese succession is more difficult. Faunally, the *P. pacificus* Zone is most similar to the *D. szechuanensis* and *A. typicus* Zones; however, the presence of rare *Diceratograptus* in the Peel River section suggests correlation with strata as high as the *Paraorthograptus uniformis* Zone of China. The latter correlation would appear to be even more reasonable if *P. uniformis* of China is, as suggested by Williams (1982), synonymous with *P. pacificus*.

Correlation of the *G. persculptus* and *P. acuminatus* Zones is relatively straightforward, and it therefore appears that strata equivalent to the *Diplograptus bohemicus* Zone of China, and the *Climacograptus*? *extraordinarius* Zone of U.S.S.R. and Scotland are unrepresented by graptolites or missing from the Yukon sections.

Conodonts and conodont correlation

Ashgill conodonts from the Blackstone and Peel River sections are regarded as being within the *Amorphognathus ordovicicus* Biozone and the North American Fauna 12. The conodont fauna at Blackstone River (Figs 1, 2) occurs 3 m below the supposed *G. persculptus* Zone and 13·7 m above the last occurrence of graptolites of the *P. pacificus* Zone.

Significant taxa include *A. ordovicicus* Branson & Mehl, *Belodina confluens* Sweet, *Besselodus* n. sp., *Gamachignathus ensifer* McCracken *et al.*, *Icriodella superba* Rhodes?, *Noixodontus girardeauensis* (Satterfield), *Oulodus ulrichi* (Stone & Furnish), *Panderodus*? *sibber* Nowlan & Barnes, *Plectodina florida* Sweet, *P. tenuis* (Branson & Mehl), *Protopanderodus* sp., *Scabbardella altipes* (Henningsmoen) and *Walliserodus amplissimus* (Serpagli). Not all of these species were initially listed by Lenz & McCracken (1982) and some have since undergone taxonomic revision.

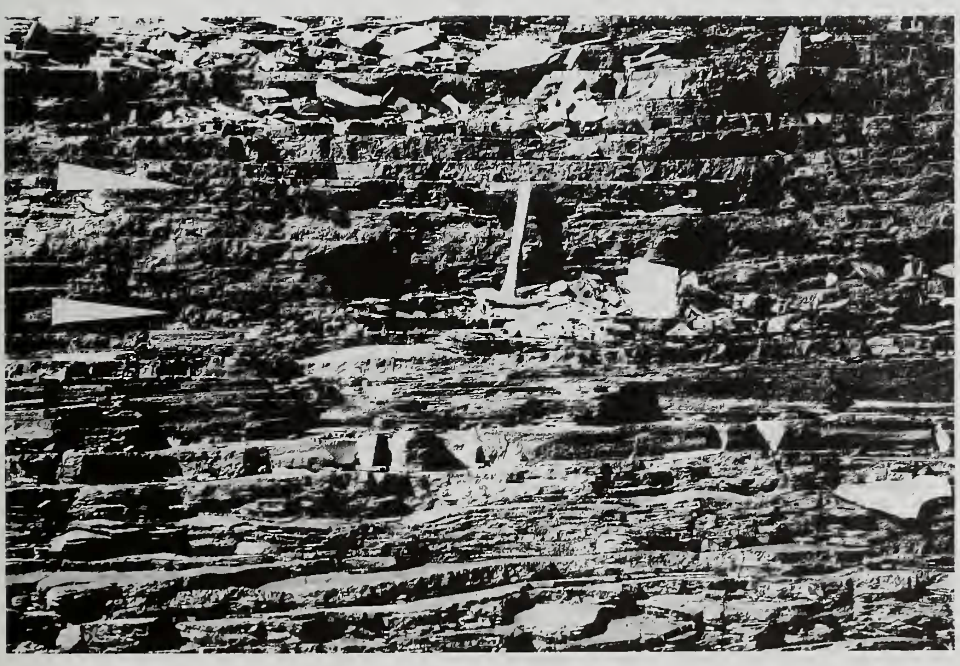

Fig. 3 Ordovician–Silurian boundary section on Peel River. Arrow on upper photograph is Ordovician–Silurian boundary. Lower photograph is a close-up of the boundary beds; the lower arrow is the top of the *P. pacificus* Zone and the upper arrow is the base of the *P. acuminatus* Zone.

One of the most noteworthy species, *N. girardeauensis*, was also found by McCracken & Barnes (1982) in Missouri in association with *Aphelognathus grandis* (Branson, Mehl & Branson) and *A. ordovicicus*. The recent work of Sweet (1984) established the *A. grandis* Chronozone; the nominal species not only occurs in the Missouri fauna, but also in the Richmondian Vauréal Formation of Anticosti Island (Nowlan & Barnes 1981). This species was not recognized in the Gamachian Fauna 13 by McCracken & Barnes (1981), but they recorded the related species *A.* aff. *A. grandis*. The range of *A. grandis* is reported to be from the upper Maysvillian through much of the Richmondian *A. divergens* Chronozone; it does not appear to range into post-Richmondian, pre-Silurian strata (Sweet 1984).

The close stratigraphical proximity of the Blackstone conodont fauna to the *G. persculptus* Zone? graptolites does not necessarily imply that it is latest Ordovician. The rare co-occurrence on Blackstone River of *G. ensifer* with *A. ordovicicus*, *B. confluens* (= *B. compressa* of Lenz & McCracken 1982), *O. ulrichi*, *P.? gibber*, *P. florida* and *P. tenuis* is comparable to the upper Vauréal Formation fauna (late Richmondian) of Nowlan & Barnes (1981). Unless the upper limit of *A. grandis* is younger than is at present known, the co-occurrence of *N. girardeauensis* and *A. grandis* in Missouri may indicate the Richmondian or, possibly, the late Maysvillian (based strictly on published microfossil data). Hence, the occurrence of *N. girardeauensis* at Blackstone River may favour a late, rather than the latest, Ordovician age. The Lower Llandovery shale and chert from both the Blackstone and Peel River sections have not been collected for conodonts.

A single *f* element of *G. ensifer* co-occurs at the Peel River section (Figs 1, 2) with some of the species listed above for the Blackstone River; *I. superba?*, *N. girardeauensis*, *O. ulrichi* and *P. florida* are absent from this fauna, whereas *O. rohneri* Ethington & Furnish and *Pseudobelodina vulgaris vulgaris* Sweet are present only at the Peel River section. Unlike the Blackstone section, where the Ordovician conodont fauna is within a thick, 16·7 m interval barren of graptolites, the Peel River conodont-bearing stratum is within a thin, 2·5 m interval bounded by shales containing graptolites of the *P. pacificus* Zone, and hence this conodont fauna is regarded as late, but not latest, Ordovician. The fauna occurs in strata 1·6–1·9 m below the systemic boundary.

Lenz & McCracken (1982) did not report Ashgill conodonts from the Pat Lake section Figs 1, 2). The sparse faunas there comprise poorly preserved conodonts that were originally assigned an early Silurian age on the basis of ramiform elements and on their stratigraphical

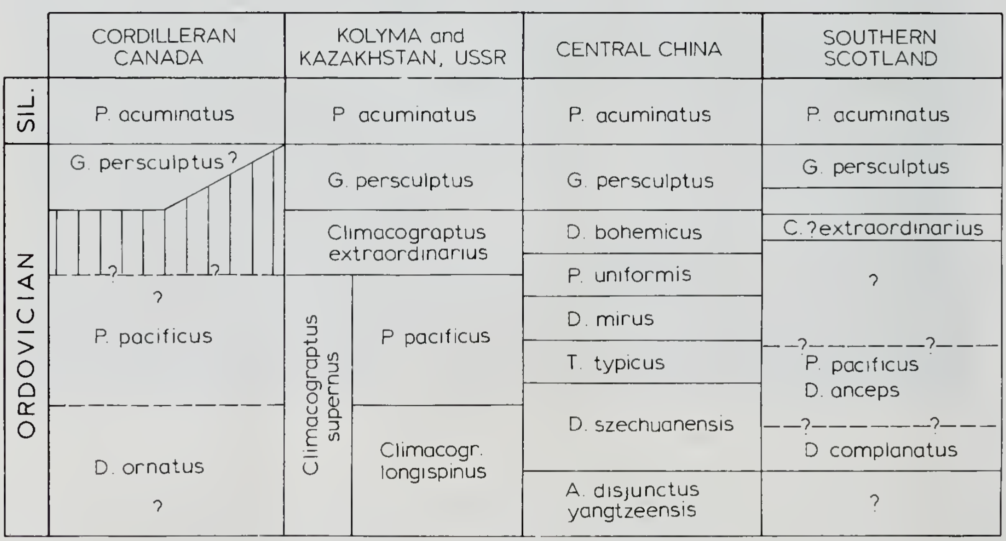

Fig. 4 Correlation of Ordovician–Silurian strata of Yukon with those of central China, U.S.S.R. and Scotland.

position with respect to *G. persculptus* Zone? graptolites. *Ozarkodina* sp. A Lenz & McCracken has a definite Silurian aspect, although this does not demand an assignment to that system since the genus has elsewhere been occasionally recognized from Upper Ordovician strata.

The poor preservation of the coniform elements limits their biostratigraphical value; they could be assigned to either Ordovician or Silurian taxa. Thus an age determination for these post-*P. pacificus* Zone and pre-*persculptus* Zone? conodonts may depend upon the positive identification of *Ozarkodina* sp. A. An unequivocal age based solely on the conodont taxa cannot be determined for the Pat Lake conodont faunas. Their occurrence below the *G. persculptus* Zone? suggests an Ordovician age.

Llandovery and younger conodont faunas are much more diverse and better preserved than those discussed herein; study of these faunas is in progress.

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